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Introduction to Software Product Lines

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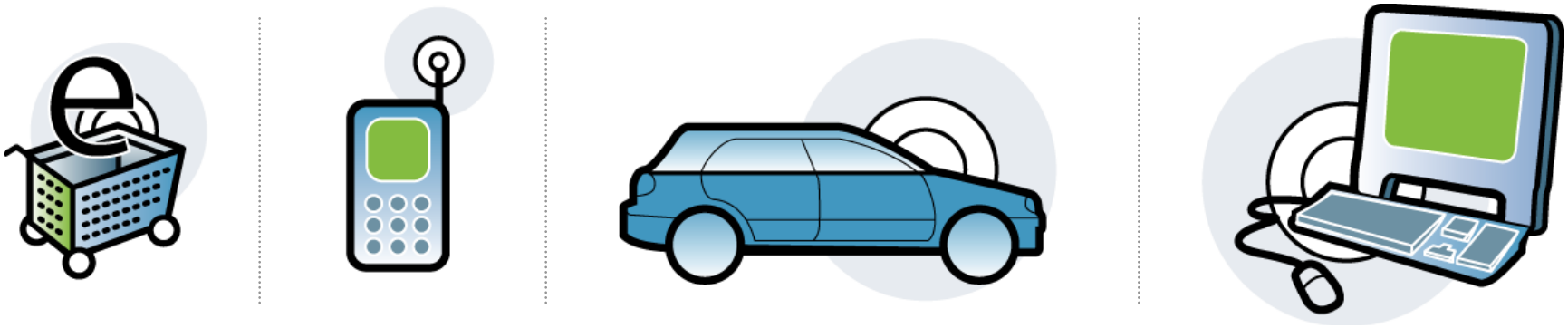
Business Success Requires Software Prowess



Software pervades every sector.

Software has become the bottom line for many organizations, even those who never envisioned themselves in the software business.

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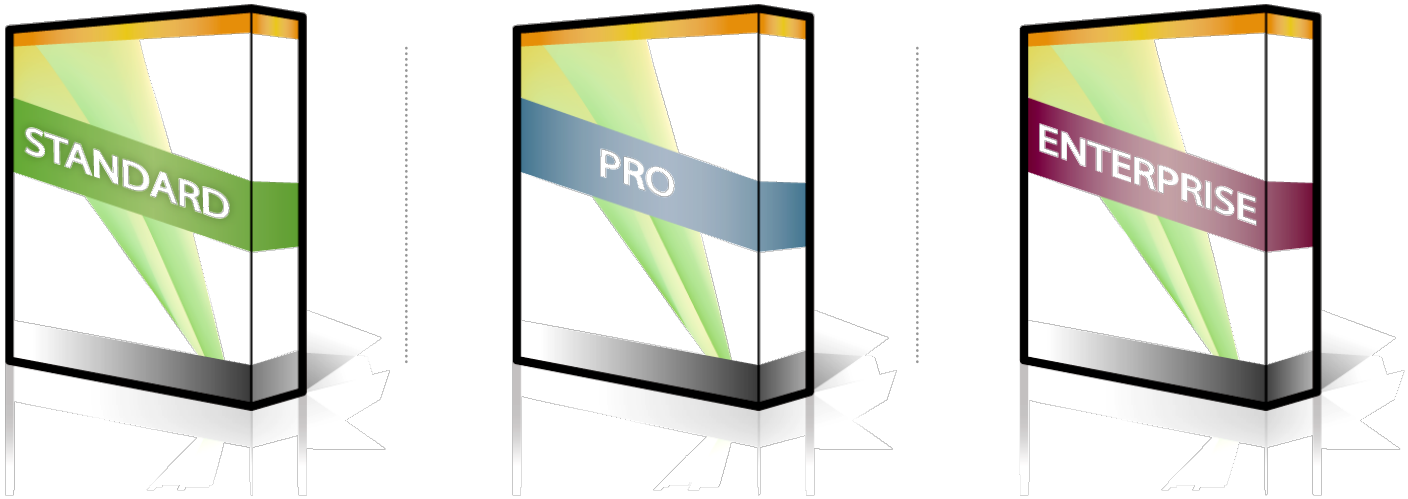
Few Systems Are Unique



Most organizations produce families of similar systems, differentiated by features.

A reuse strategy makes sense.

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What Is a Software Product Line?

A *software product line* is a set of software-intensive systems sharing a common, managed set of features that satisfy the specific needs of a particular market segment or mission and that are developed from a common set of core assets in a prescribed way.

- a new application of a proven concept
- an innovative, growing concept in software engineering

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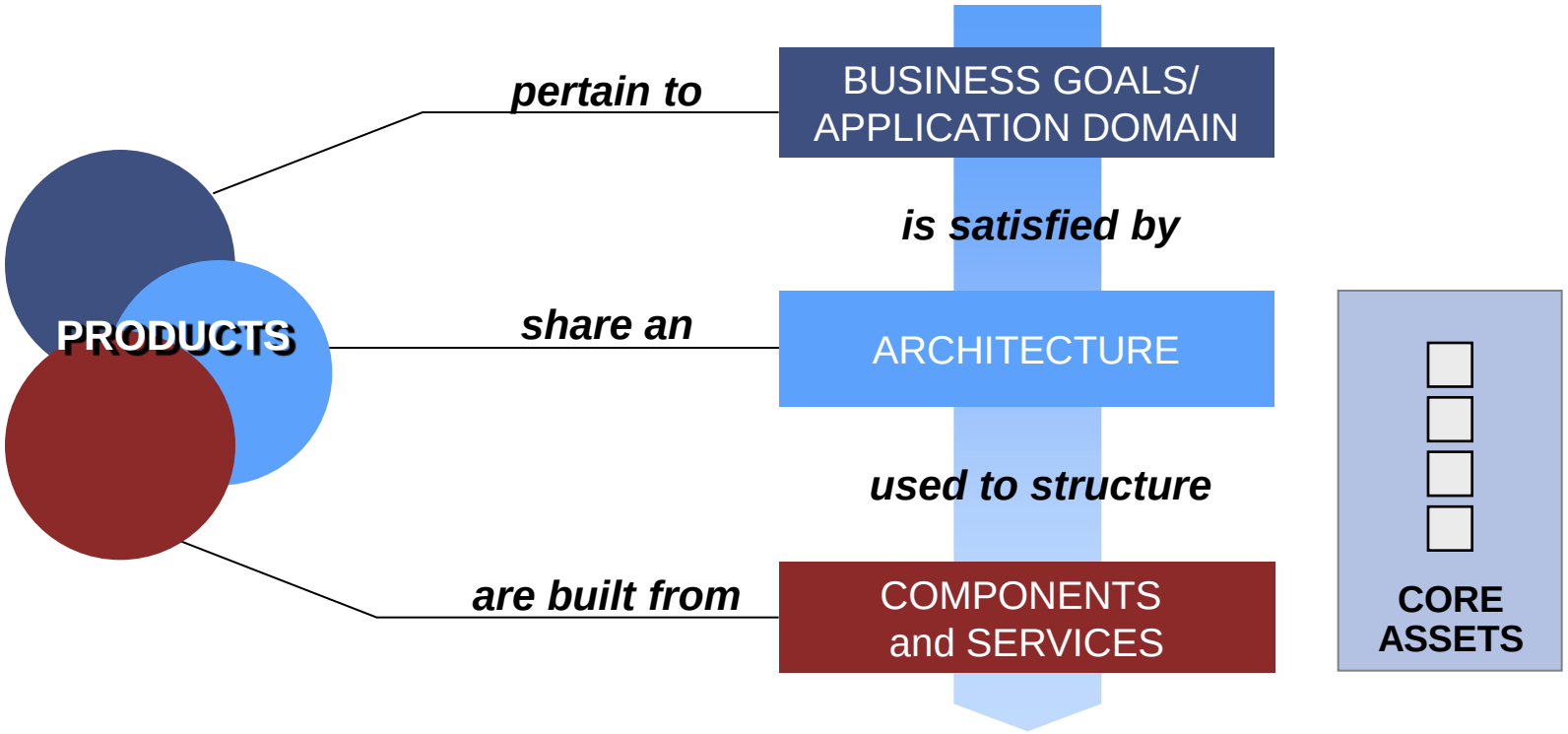
Software Product Lines



Product lines

- take economic advantage of commonality
- bound variation

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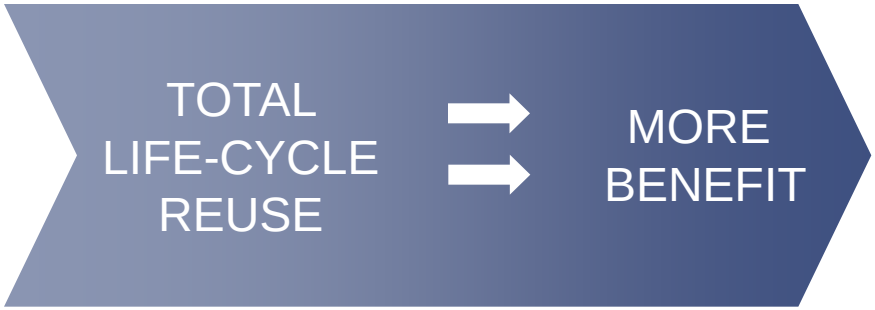
How Do Product Lines Help?

Product lines amortize the investment in these and other *core assets*:

- requirements and requirements analysis
- domain model
- software architecture and design
- performance engineering
- documentation
- test plans, test cases, and test data
- people: their knowledge and skills
- processes, methods, and tools
- defect elimination
- budgets, schedules, and work plans
- components and services



PRODUCT LINES = STRATEGIC REUSE

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Organizational Benefits

Organizations use product line practices to

- achieve large-scale productivity gains
- improve time to market
- maintain market presence
- sustain unprecedented growth
- achieve greater market agility
- compensate for an inability to hire
- enable mass customization
- get control of diverse product configurations
- improve product quality
- increase customer satisfaction
- increase predictability of cost, schedule, and quality

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Costs of a Software Product Line

Core Assets	Costs
Architecture	Must support variation inherent in the product line
Software Components	Must be designed to be general without a loss of performance; must build in support for variation points
Test Plans, Test Cases, Test Data	Must consider variation points and multiple instances of the product line
Business Case and Market Analysis	Must address a family of software products, not just one product
Project Plans	Must be generic or be made extensible to accommodate product variations
Tools and Processes	Must be more robust
People, Skills, Training	Must involve training and expertise centered around the assets and procedures associated with the product line

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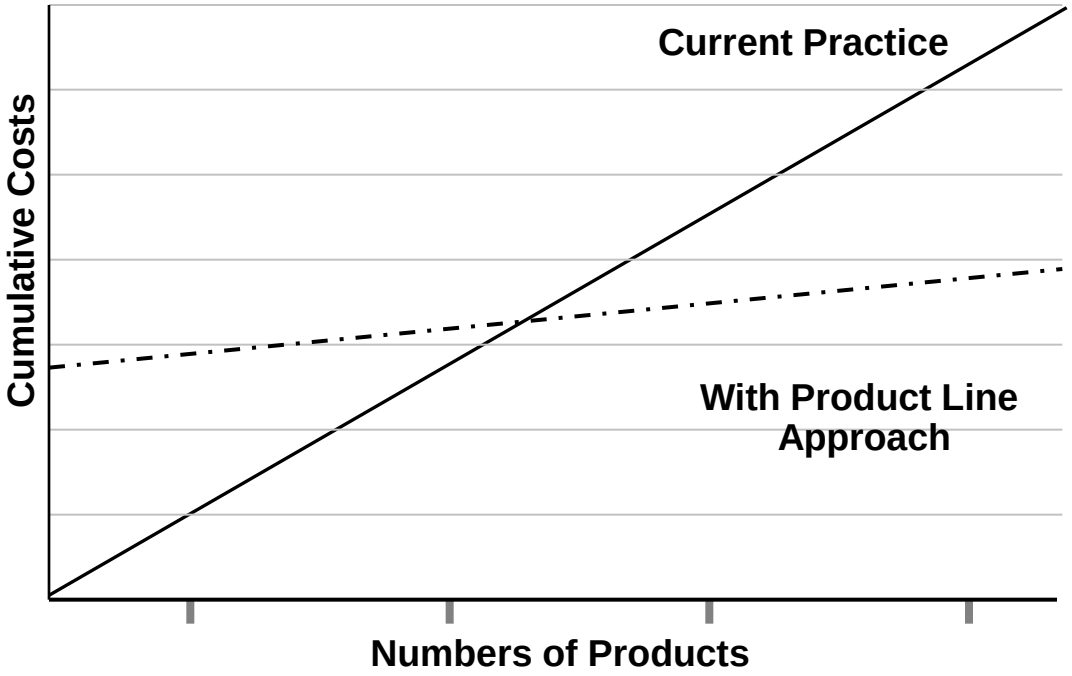
Economics of Product Lines



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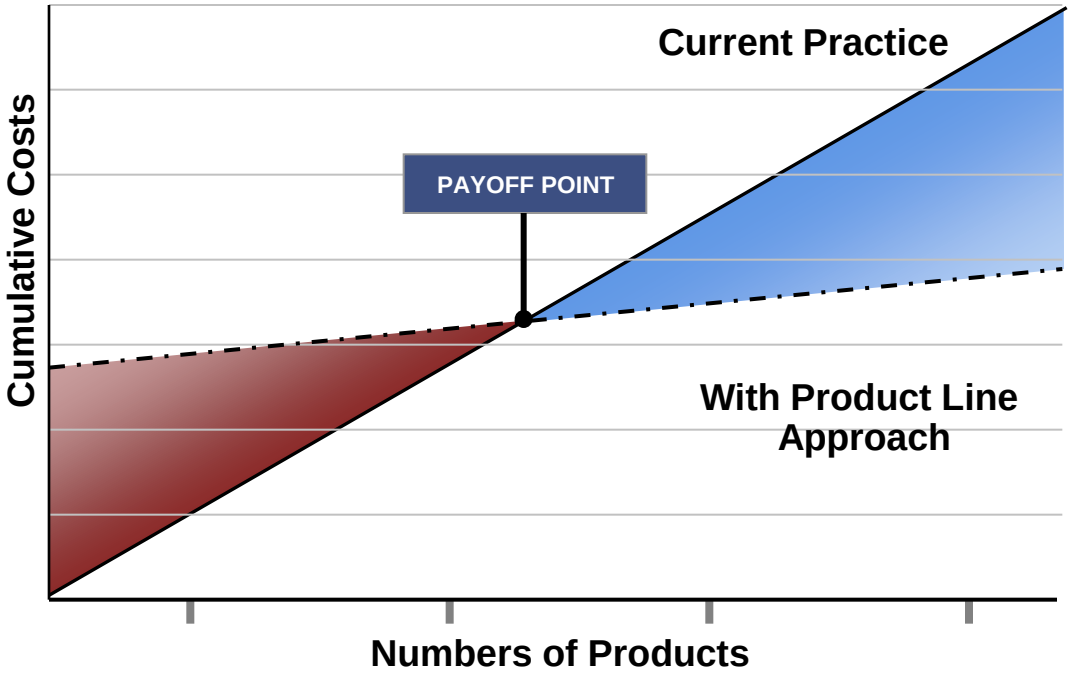
Economics of Product Lines



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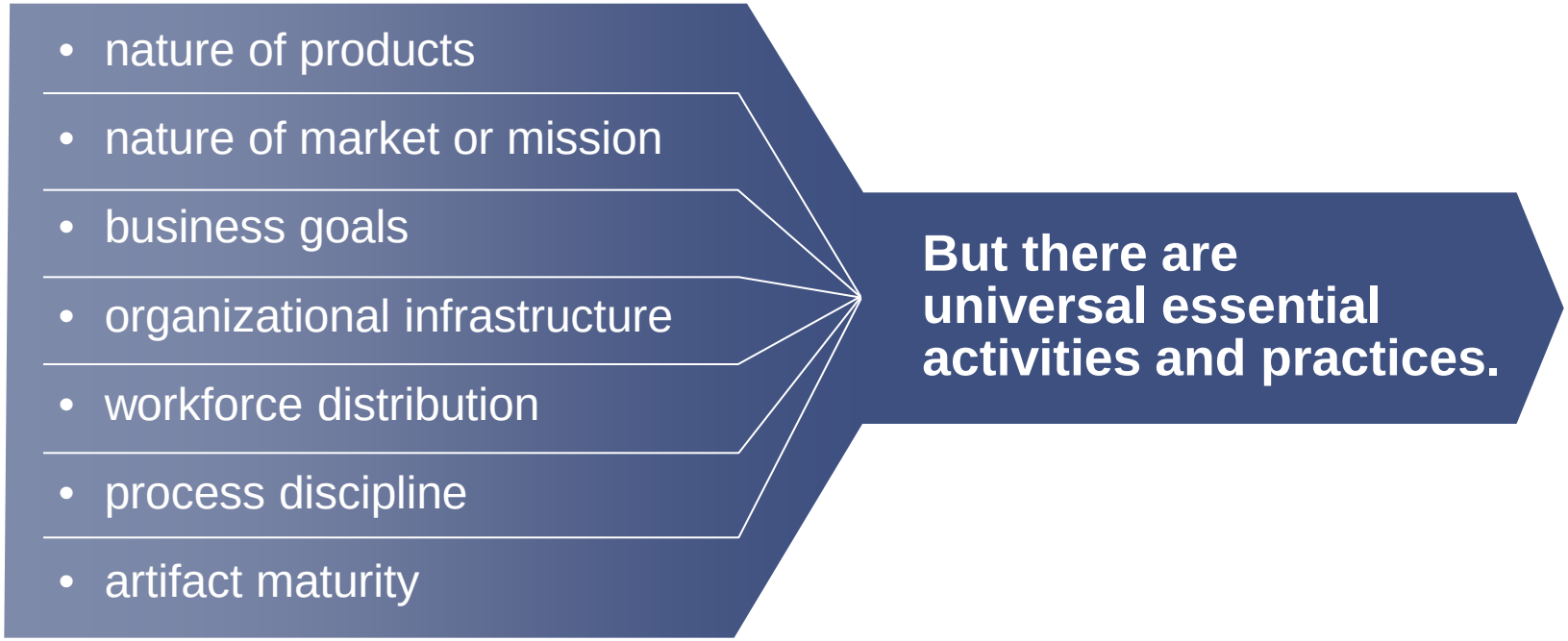
Product Line Practice

Contexts for product lines vary widely, based on



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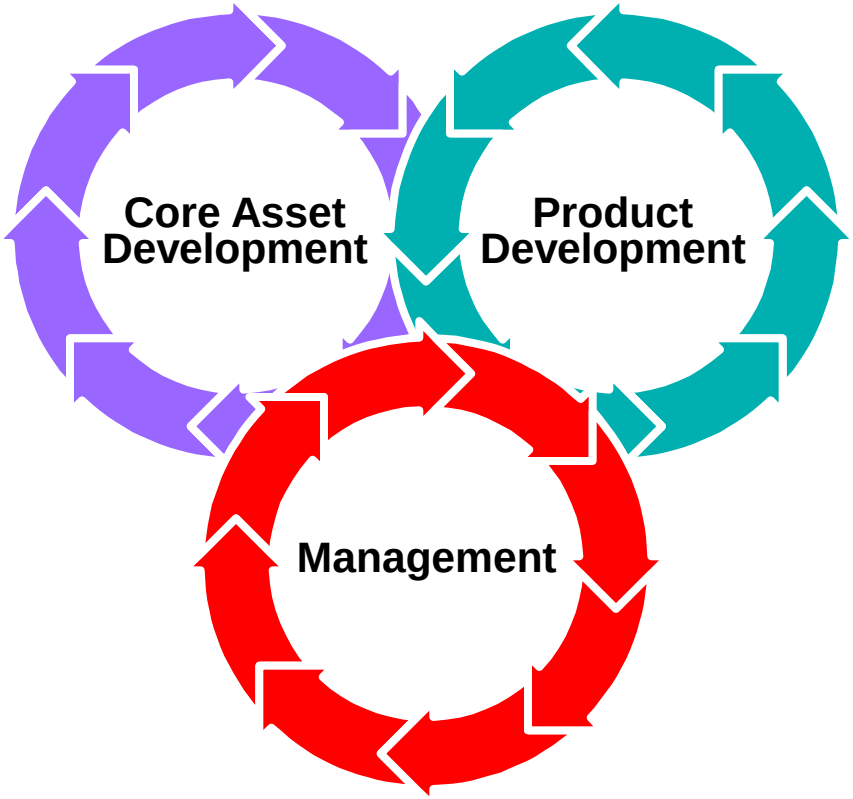
The Three Essential Activities



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Different Approaches - 1

Proactive: Develop the core assets first.

- Develop the scope first and use it as a “mission” statement.
- Products come to market quickly with minimum code writing.
- Requires up-front investment and predictive knowledge

Reactive: Start with one or more products.

- From them, generate the product line core assets and then future products; the scope evolves more dramatically.
- Much lower cost of entry
- The architecture and other core assets must be robust, extensible, and appropriate to future product line needs.

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Different Approaches - 2

Incremental: In either a reactive or proactive approach, it is possible to develop the core asset base in stages, while planning from the beginning to develop a product line.

- Develop part of the core asset base, including the architecture and some of the components.
- Develop one or more products.
- Develop part of the rest of the core asset base.
- Develop more products.
- Evolve more of the core asset base.
- …

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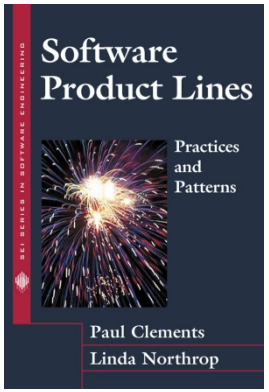
The SEI Framework for Software Product Line Practice[SM]

The SEI Framework for Software Product Line Practice is a conceptual framework that describes the essential activities and twenty-nine practice areas necessary for successful software product lines.

The Framework, originally conceived in 1998, is evolving based on the experience and information provided by the community.



Version 4.0 –
in *Software Product Lines: Practices and Patterns*

Version 5.0 –
http://www.sei.cmu.edu/productlines/tools/framework/index.cfm

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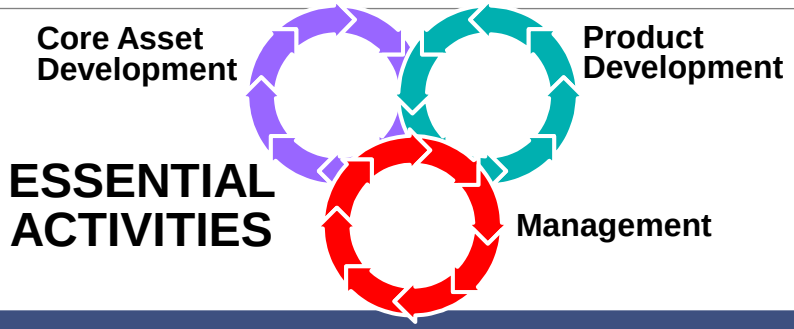
Framework Version 5.0



PRACTICE AREAS		
Software Engineering	Technical Management	Organizational Management
Architecture Definition	Configuration Management	Building a Business Case
Architecture Evaluation	Make/Buy/Mine/Commission Analysis	Customer Interface Management
Component Development	Measurement and Tracking	Developing an Acquisition Strategy
Mining Existing Assets	Process Discipline	Funding
Requirements Engineering	Scoping	Launching and Institutionalizing
Software System Integration	Technical Planning	Market Analysis
Testing	Technical Risk Management	Operations
Understanding Relevant Domains	Tool Support	Organizational Planning
Using Externally Available Software		Organizational Risk Management
		Structuring the Organization
		Technology Forecasting
		Training

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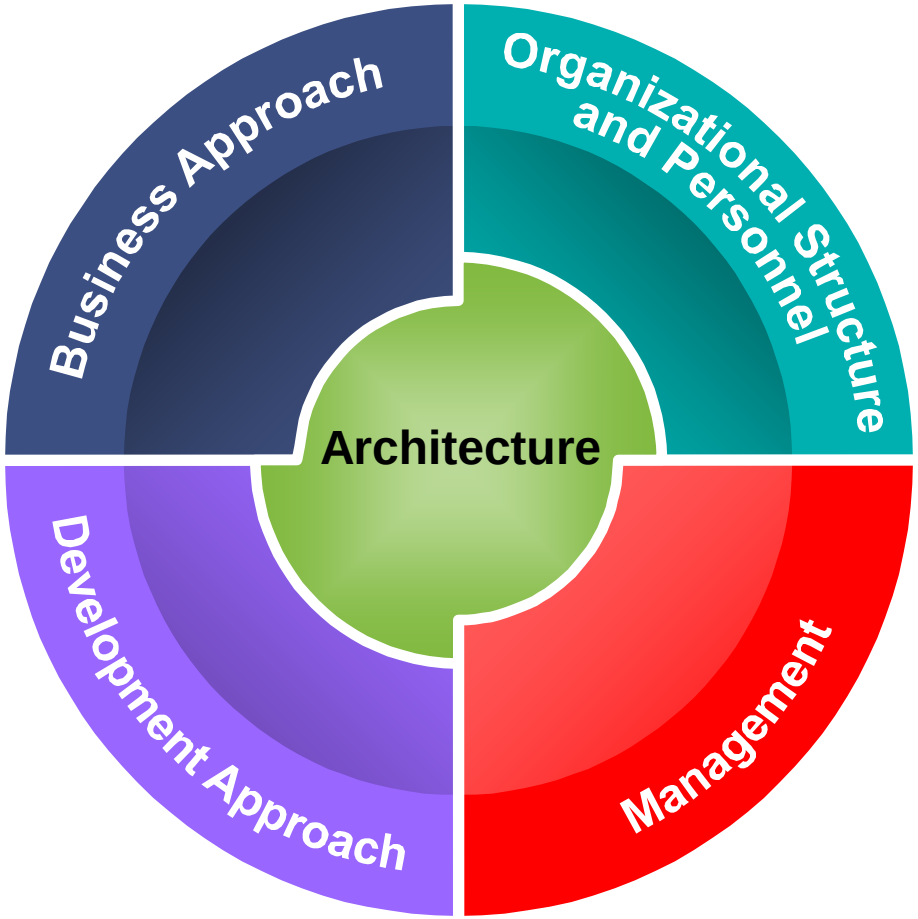
Necessary Changes



The product line architecture is central to success.

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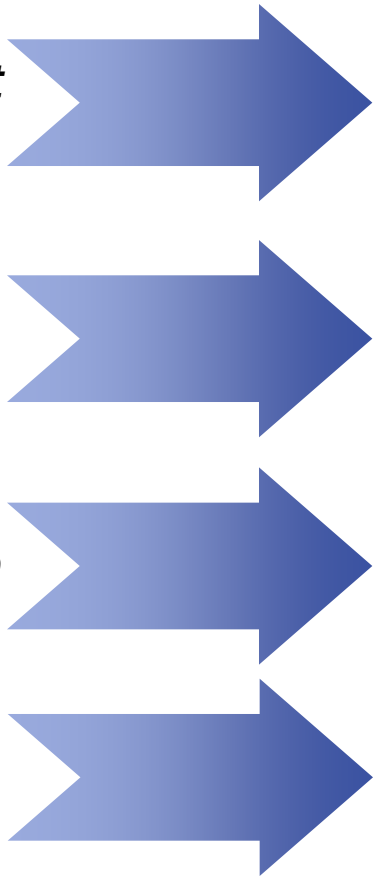
Why Is Software Architecture Important?

Architecture



Represents ***earliest*** design decisions

- hardest to change
- most critical to get right
- communication vehicle among stakeholders

First design artifact addressing

- performance
- modifiability
- reliability
- security

Key to systematic ***reuse***

- transferable, reusable abstraction

Key to system ***evolution***

- manage future uncertainty
- assure cost-effective agility

The **right architecture** paves the way for system **success**.
The **wrong architecture** usually spells some form of **disaster**.

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At the Heart of Successful Product Lines

A pressing need that addresses the heart of the business

Long and deep domain experience

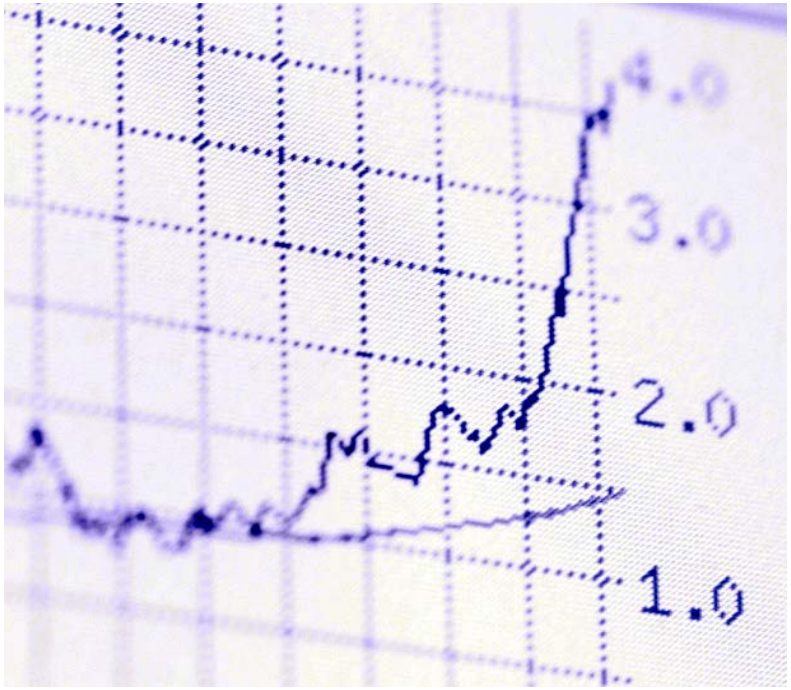
A legacy base from which to build

Architectural excellence

Process discipline

Management commitment

Loyalty to the product line as a single entity



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The Product Line Adoption Endgame

To have an **operational software product line.**

To do that, an organization must

- have
  - a core asset base
  - supportive processes and organizational structures
- develop products from that asset base in a way that achieves business goals
- prepare itself to institutionalize product line practices

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Widespread Use of Software Product Lines

Successful software product lines have been built for families of among other things

- mobile phones
- shipboard command and control systems
- satellite ground-station systems
- avionics systems
- command and control/situational awareness systems
- pagers
- engine control systems
- mass storage devices
- billing systems
- Web-based retail systems
- printers
- consumer electronic products
- acquisition management enterprise systems
- financial and tax systems
- medical devices
- fish farm management software

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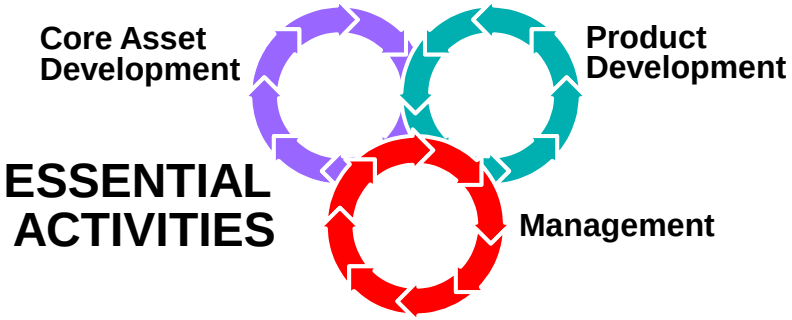
In a Nutshell

Software product lines epitomize the concept of strategic, planned reuse.

The product line concept is about more than a new technology. It is a new way of doing one's software business.

There are essential product line activities and practices areas as well as product line patterns to make the move to product lines more manageable.



PRACTICE AREAS		
Software Engineering	Technical Management	Organizational Management

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